



**Title:** Visible and Near Infrared Observation on the Global Aerosol Backscatter Experiment (GLOBE)

**Authors:** James D. Spinhirne, NASA/Goddard Space Flight Center  
John F. Cavanaugh, NASA/Goddard Space Flight Center  
S. Chudamani, Science Applications International Corporation  
Jack L. Bufton, NASA/Goddard Space Flight Center  
Robert J. Sullivan, NASA/Goddard Space Flight Center

NC 99996

S/288724

**Discipline:** Atmosphere

The Global Aerosol Backscatter Experiment (GLOBE) was intended to provide data on prevailing values of atmospheric backscatter cross-section. The primary intent was predicting the performance of spaceborne lidar systems, most notably the Laser Atmospheric Wind Sounder (LAWS) for EOS. A second and related goal was to understand the source and characteristics of atmospheric aerosol particles. For remote ocean locations, and the Southern hemisphere in general, a significant lack of knowledge exists. The major components of the experiment were flight surveys throughout the Pacific region by the NASA DC-8 aircraft. A Goddard Space Flight Center lidar system was operated on the missions to obtain aerosol backscatter cross-section at the fundamental and doubled Nd:YAG laser wavelengths of 1.064 and 0.532  $\mu\text{m}$  and, in addition, at a wavelength of 1.54  $\mu\text{m}$  which was generated by Raman shifted down conversion of the 1.064  $\mu\text{m}$  radiation. The system was the first operational lidar at the one-and-a-half micron wavelength region. Advantages of one-and-a-half micron lidar is eye safe operation and increased sensitivity to aerosol characteristics. An important factor of the visible/near infrared backscatter measurements is accurate calibration. A new scattering cross-section calibration technique based on hard target laser measurements was developed for the experiment. In this paper, we will present details of the instrument design and aircraft operations and also discuss initial results.

The lidar instrument was integrated on the NASA DC-8 to operate through nadir and zenith windows. A 50 Hz PRF Nd:YAG laser was the basic transmitter. The 1.54  $\mu\text{m}$  transmitted pulse was generated by Raman shifted down conversion of the 1.064  $\mu\text{m}$  radiation by transmitting the 1.064  $\mu\text{m}$  pulse through a Raman cell containing 300 psi of methane gas. The cell converted approximately 15% of a 200 mJ pulse to 1.54  $\mu\text{m}$  energy. The longer wavelengths were combined with the 0.532  $\mu\text{m}$  pulse, and all three wavelengths were transmitted co-axial to the receiver telescope. In order to obtain the calibrated backscatter cross-section measurement, a critical component of the system was an accurate pulse energy monitor. In the design that was used, a polarization insensitive flat directed a small fraction of the transmitted pulse energies into an integrating sphere, and fiber optics carried signals to filters and pulse integrators. In order to maintain stability, the energy monitor filters and detectors were temperature-controlled. The receiver filters and detectors



were also temperature-controlled. All detectors were solid state. The receiver telescope was designed to be rotated in order that observations could be acquired in either the nadir or zenith direction. Signals were digitized by a CAMAC data system and recorded on optical disks.

The GLOBE flights were carried out in November 1989 and May-June 1990. The region of the central and eastern Pacific was traversed by the NASA DC-8 at an altitude range of roughly 8 to 10 km. Latitudes from approximately 70°N to 70°S were covered. In addition to point-to-point traverse flights, there were local missions where flight lines at different altitudes were flown at a single location. On the local flights, lidar measurements from different heights could be intercompared. Also, the lidar backscatter measurements could be intercompared to the complement of *in situ* particle probe measurements that were included on the DC-8 mission. A number of intercomparisons to ground-based lidar and measurements by other aerosol sampling aircraft were also carried out during the missions.

The overall analysis of results from the GLOBE missions is not yet completed, but initial results can be discussed. In general, there were three vertical regions observed: the mixed boundary layer, a cloud-pumped layer, and the free troposphere. Aerosol scattering varies by over four orders of magnitude, and cross-sections in the mixed and cloud-pumped layer are typically several orders of magnitude above that for the free troposphere. The upper troposphere is generally very free of aerosol scattering. However, areas of increased aerosol concentration are found. It may be generally stated that the upper troposphere aerosol scattering cross-section was low in the Southern hemisphere for the May-June flights and low for the Northern hemisphere for the November flights. The initial results indicate that the instrumentation and calibration techniques applied for the near IR lidar measurements were successful.

From the GLOBE flights, extensive data have been obtained on the structure of clouds and the marine planetary boundary layer. A notable result for all observations is the consistency of the large increases in aerosol scattering ratio for the marine boundary layer. Large increases in scattering ratio at the boundary layer, as mentioned above, were found in most all cases. Another interesting aspect of the lidar cloud observations over the Pacific, at least for the November data, was the frequency of low cloud density. For a large fraction of the cloud observations, lidar return signals were obtained through extended layers. Large areas of clouds with observed vertical structure from 4 to 8 km thick were under and over flown. The potential for extended signal returns through clouds is a possibly significant factor for laser wind measurements.